How Anti-shoplifting Devices Work

Let's imagine for the moment that you own a large department store, and you are having a big problem with shoplifting. (You're not alone -- retail stores lost $26 billion last year to shoplifting!) What are you going to do? You cannot let it continue, because every month your accounting system tells you that you are losing thousands of dollars to theft. It forces you to raise your prices, and that means you have to charge more than the store next door. That can make it very hard to compete, especially if the store next door is successfully discouraging shoplifting.

As a retailer focusing on the problem of what's known in the industry as **loss prevention**, you basically have three methods at your disposal to slow the shoplifters down: (1) You can watch everyone in the store like a hawk and make sure they don't steal anything. You can do that using security guards and/or video surveillance systems; (2) You can make things hard to remove from the store by bolting them down, attaching cables, putting things in display cases and behind the counter; (3) You can use a system that attaches special **tags** onto everything so that an alarm goes off whenever a shoplifter tries to walk out with an item. In this edition of How Stuff Works, we'll look at each of these options in more detail.

How Does Video Surveillance Work?

Our first option involves the use of deterrents such as security guards, observation mirrors (that allow store clerks to see throughout the store) and **closed-circuit television (CCTV)** surveillance systems. Most large stores use some combination of these techniques, which were among the earliest tools used to combat shoplifting. Smaller businesses, unable to afford security guards, were able to install videocameras -- usually in a prominent place so that shoppers knew they were being watched -- to record activity in the store. Later, the retailer could review the tapes on a VCR, observe shoppers behaving suspiciously (sometimes even stealing) and note the vulnerable displays or areas in the store. The problem with this record-and-review system is that some shoplifters get away with stealing. On the other hand, experts say, the system has merit in that it allows for possible recognition of repeat offenders (something that is prevalent among shoplifters). By reviewing these tapes, the store owner can also learn about theft patterns and get ideas about ways to deal with them.

Your imaginary department store would probably use electronic surveillance a bit differently than smaller businesses. You might have security staff monitoring store activity on closed-circuit TV as it happens in an effort to prevent shoplifting. Today, there are even systems that allow retailers with several locations to monitor stores and distribution centers from a single location. These remote surveillance systems allow users to send full-frame video image streams over high-speed phone lines to other locations and to electronically store digital video images for review or evidence.

And in larger stores, cameras are often less visible. Next time you're in your favorite department store, look around. High-speed, high-resolution digital cameras may be mounted in smoke detectors, sprinkler heads, thermostats or clocks. (It's popular to mount cameras in **c iling tile d mes** (they're bubble-like and tinted so no one can see where the camera is pointed). From this vantage point, a **pan/tilt/z om**

camera can swing about and follow someone around the store. (If security is not monitoring and operating the camera, it can be set up to pan automatically but will not follow someone around the store.)

Video cameras used for security purposes don't look anything like the video camera your family has at home -- they're becoming smaller and more specialized. A standard surveillance camera might be in the neighborhood of 4 inches long by 2 1/2 inches wide with a lens on the end, according to Jeff Bates of ADT Security Systems in Raleigh, N.C. A hidden camera might be a board camera, which basically is a 1 inch by 1 inch square computer board with a tiny lens, perhaps 1/4 inch in size. These cameras are designed to two specifications, experts say: they must be small and easy to hide.

Is Anchoring the Merchandise in Place a Good Idea?

Now for option number two: locking things up nice and tight. **Cable, wire products and security bars**, like those manufactured by Se-Kure Controls (Canada) Inc., are also familiar types of retail security devices. They certainly work to keep your merchandise in the store! But retail industry experts say this isn't the best way to move your products because cables and other locking devices make it difficult for people to examine items and try on garments. Customers have to get a clerk to come release the item so they can try it on or look at it. Since most people are in a hurry, this might motivate shoppers to move on to a store where the merchandise is more accessible.

Having said that, if you need to use security cables and locking racks, there's a wide variety of products available to you. Security cables are made with a variety of properties: coaxial cables (for CCTV systems), alarm cables and fiberoptic cables. **Wire lanyards**, which can be snaked through a garment to attach it to a rack or display, are being made stronger all the time. For example, Retail Security Products offers to send potential customers a lanyard test kit to illustrate the strength -- over 250 pounds in a pull test -- of their product. You've probably also seen the locked steel racks used for expensive coats and jackets -- again, these have to be unlocked by a sales clerk.

How Do Tag and Alarm Systems Work?

Security experts say the most effective anti-shoplifting tools these days are CCTV and the tag-and-alarm systems, better known as **electronic article surveillance (EAS)** systems. Separately, these are good options. Used together, experts say, they're almost unbeatable. EAS is a technology used to identify articles as they pass through a gated area in a store. This identification is used to alert someone that unauthorized removal of items is being attempted. According to the Association of Automated Identification Manufacturers, over 800,000 EAS systems have been installed worldwide, primarily in the retail arena. EAS systems are useful anywhere there is an opportunity for theft of items of any size. Using an EAS system enables the retailer to display popular items on the floor, where they can be seen, rather than putting them in locked cases or behind the counter.

Loss prevention expert Robert L. DiLonardo, says new EAS technologies are being produced -- not only to reduce shoplifting -- but also to help increase sales, lower labor costs, speed inventory, improve stockroom logistics and, one day, to replace inventory record-keeping. But for now, we'll stick to the role of EAS in battling shoplifting in your imaginary store!

Three types of EAS systems dominate the retail industry. In each case, an EAS tag or label is attached to an item. The tag is then **deactivated**, or taken from an active state where it will alarm an EAS system to an inactive state where it will not flag the alarm. If the tag is a hard, reusable tag, a detacher is used to remove it when a customer purchases the item it's attached to. If it's a disposable, paper tag, it can be deactivated by swiping it over a pad or with a handheld scanner that "tells" the tag it's been authorized to leave the store. If the item has not been deactivated or detached by the clerk, when it is carried through the gates, an alarm will sound.

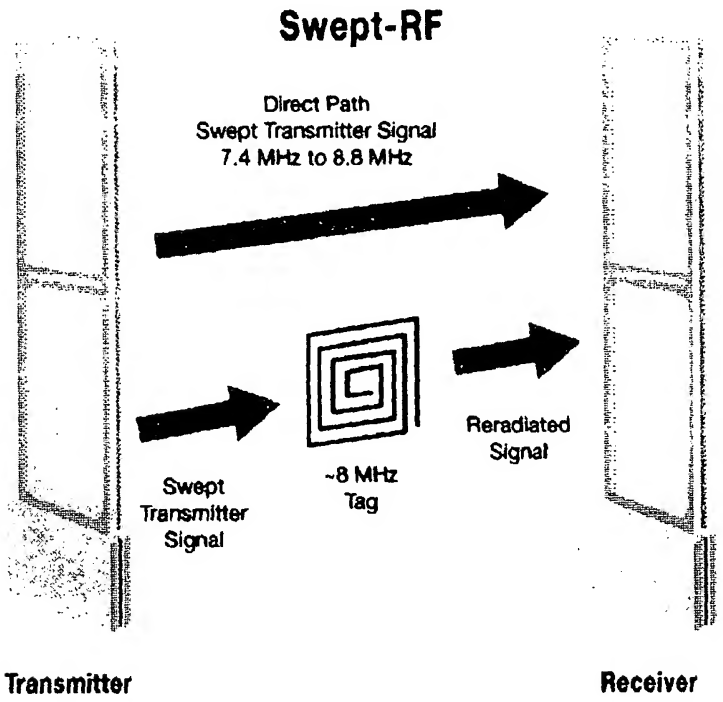
The use of EAS systems does not complet ly eliminate shoplifting. However, experts say, theft can be reduced by 60 percent or more when a reliable system is used. Even when a shoplifter manages to leave the store with a tagged item, the tag still must be removed -- something that is no longer as easy

as it once was. For example, some EAS tags contain special ink capsules, which will damage the stolen item when forcibly, and illegally, removed. (This type of device is known in the industry as **benefit denial** -- we'll discuss it more later!). Other popular EAS components today include **source tagging**, whereby an inexpensive label is integrated into the product or its packaging by the manufacturer.

The type of EAS system dictates how wide the exit/entrance aisle may be, and the physics of a particular EAS tag and technology determines which frequency range is used to create a surveillance area. EAS systems range from very low frequencies through the radio frequency range (see How Radio Scanners Work). These EAS systems operate on different principles, are not compatible and have specific benefits and disadvantages. (That's why the Consumer Products Manufacturers Association Inc. is encouraging a "tower-centric" EAS approach that can "read" multiple tag technologies rather than the "tag-centric" models that exist today.)

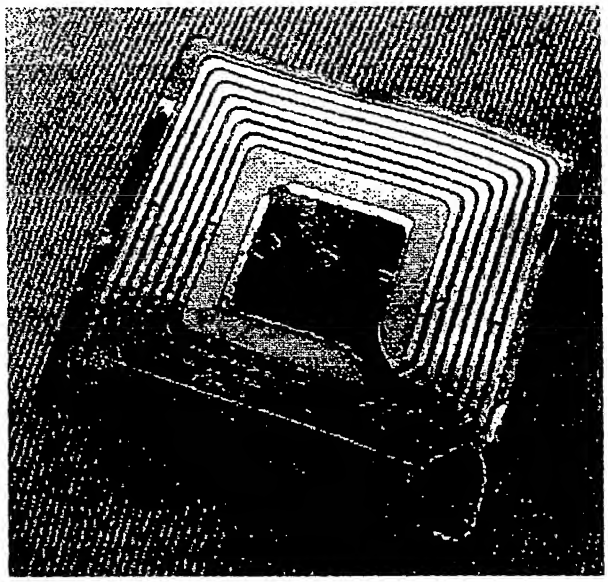
How Do Radio Frequency EAS Systems Work?

Radio Frequency (RF) Systems are the most widely used systems in the United States today and RF tags and labels are getting smaller all the time. As you can see in the drawing at the right, the RF EAS system works like this: A label -- basically a miniature, disposable **electronic circuit** and **antenna** -- attached to a product responds to a specific frequency emitted by a transmitter antenna (usually one pedestal of the entry/exit gate). The response from the label is then picked up by an adjacent receiver antenna (the other pedestal). This processes the label response signal and will trigger an alarm when it matches specific criteria. The distance between the two gates, or pedestals, can be up to 80 inches wide. Operating frequencies for RF systems generally range from 2 to 10 MHz (millions of cycles per second); this has become standard in many countries. Most of the time, RF systems use a **frequency sweep** technique in order to deal with different label frequencies.



Sometimes both the transmitter and receiver are combined in one antenna frame -- these are called **m no systems** and they can apply pulse or continuous sweep techniques or a combination of both. According to Tag Point Ltd. xperts, mono systems could be effective for you if your store's entry is small. The mono system is used with hard labels, which are slightly more expensive than paper labels used with RF sweep techniques.

Sensors (gates/pedestals) made by Checkpoint Systems, one of the largest manufacturers of EAS products, emit a low-energy RF pulse, which "listens" for the tag. This technology, known as **digital signal processing**, actually "learns" about its surroundings so that it can accurately distinguish between the tag signal and extraneous noise. Store employees love this because it virtually eliminates false alarms! (Store owners often ask why there are no invisible sensors. Cross Point experts say it is technically possible to create an invisible system by, for example, installing an antenna loop around a store's door. However, tests have shown that the preventive value of a visible system is greater and results in decreased theft.)



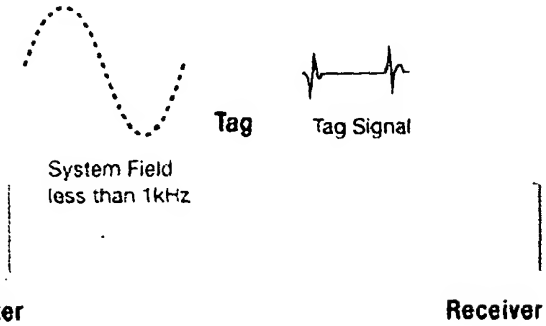
This tag is about 1.5 inches (3 cm) square. On the other side is an innocuous paper label that says, "Thank you for shopping with us!"

There are many different ways to implement an RF system (see this patent and the patents it references for one type of implementation). The basic idea is that the tag has a helical antenna etched from thin aluminum bonded to a piece of paper. At the end of the antenna is a small diode or RC network that causes the tag to emit a radio signal in response to the radio signal it receives. To disarm the tag, a strong RF pulse (much stronger than the gates emit) blasts the tag and burns out the diode or RC components. Between the gates a burned out tag does not emit a signal, so the gates let it pass without an alarm.

How Does An Electromagnetic System Work?

The **Electromagnetic (EM) system**, which is dominant in Europe, is used by many retail chain stores, supermarkets and libraries around the world. In this technology, a magnetic, iron-containing strip with an adhesive layer is attached to the merchandise. This strip is not removed at checkout -- it's simply deactivated by a scanner that uses a specific highly intense magnetic field. (One of the advantages of the EM strip is that it can be re-activated and used at a low cost.)

Electromagnetic



What most people refer to as an electromagnetic tag is actually a metal wire or ribbon that has high **permeability**, making it easy for magnetic signals to flow through it, according to Sensormatic's EAS Product Co. CTO Hap Patterson. "When we drive the tag, flux is being allowed to flow through the tag until it's saturated," he says. "When it's saturated, from a magnetic perspective, it begins to look like air. Saturation occurs abruptly and is an important part of the design of the tag."

Look at the figure showing the EM system with its receive coil and transmitter on either side and tag in the middle. When the tag goes from active to saturated, the receiver detects the change in the amount of the signal picked up from the transmitter. "If you look at the receiver signal, you'll see a bump when saturation occurs," Patterson says. Saturation occurs twice each cycle-once on the transmitter's positive cycle and once on its negative cycle. What is happening is the system is checking for the special material used to make the tag. (In scientific terms, the permeability of steel is much lower than the metal used to make the tag. In addition, when steel goes to saturation, it tends to do so slowly, not abruptly. So the EM system uses these differences to differentiate between a still-active tagged item leaving the store and a wrench in someone's pocket.)

A magnetized piece of semi-hard magnetic material (basically, a weak magnet) is put up next to the active material to deactivate it. When you magnetize the semi-hard material, it saturates the tag and puts it in its inactive saturated state.

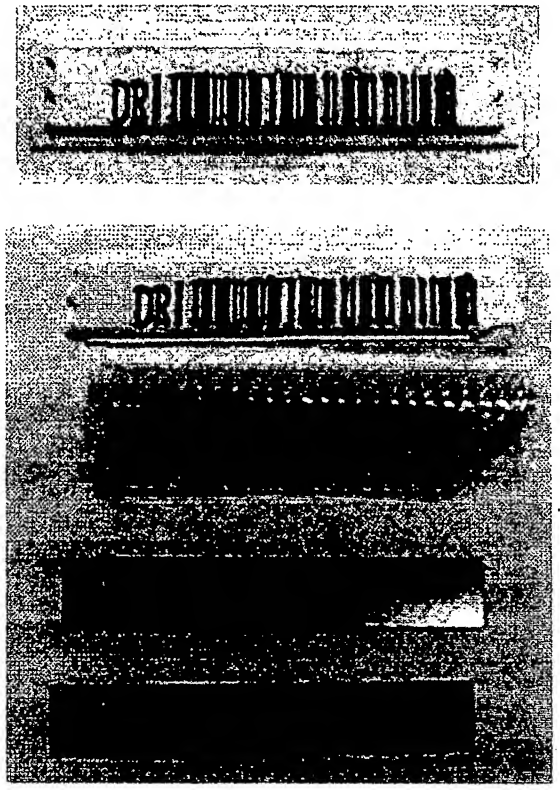
That same kind of tag is often used in the library, where it can be reactivated by demagnetizing the semi-hard magnetic material.

The EM system works by applying intensive low frequency magnetic fields generated by the transmitter antenna. When the strip passes through the gate, it will transmit a unique frequency pattern. This pattern is, in turn, being picked up by an adjacent receiver antenna. The small signal is processed and will trigger the alarm when the specific pattern is recognized. Because of the weak response of the strip and the low frequency (typically between 70 Hz and 1 kHz) and intensive field required by the EM system, EM antennas are larger than those used by most other EAS systems, and the maximum distance between entry pedestals is 40 inches. Also, because of the low frequency here, the strips can be directly attached to metal surfaces. That's why EM systems are popular with hardware, book and record stores. (Check out the patent for more details!)

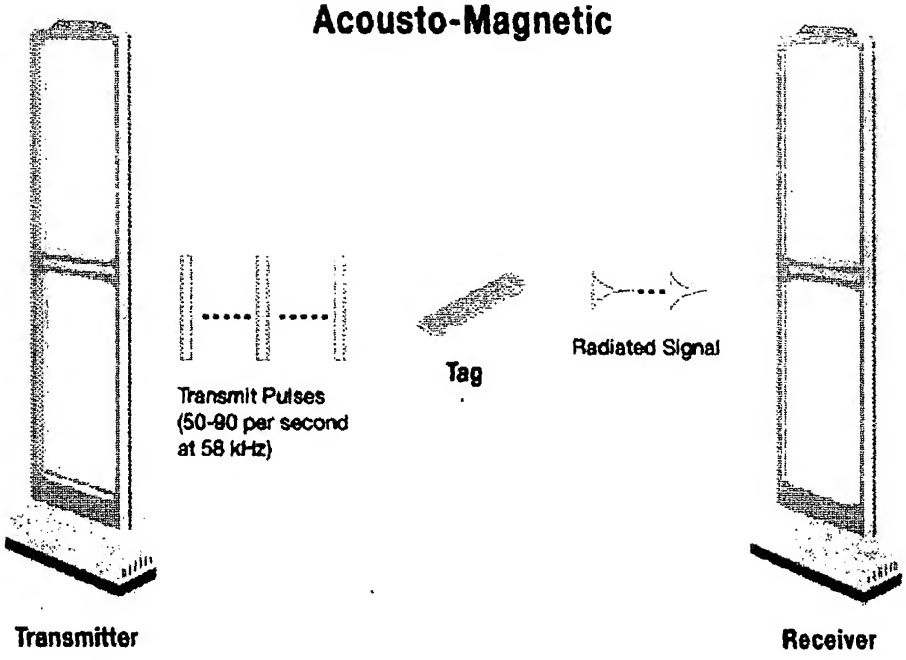
What's the Third Type of EAS System Used Most Often?

The newer **acousto-magnetic system**, which has the ability to protect wide exits and allows for high-speed label application, uses a transmitter to create a surv illance area where tags and labels are detected. The transmitter sends a radio frequency signal (of about 58 kHz) in pulses, which energize a tag in the surveillance zone. When the pulse ends, the tag responds, emitting a single frequency signal like a tuning fork. While the transmitter is off between pulses, the tag signal is detected by a receiver. A

microcomputer checks the tag signal detected by the receiver to ensure it is at the right frequency, is time-synchronized to the transmitter, at the proper level and at the correct repetition rate. If all these criteria are met, the alarm occurs.



A typical AM tag from Wal-Mart



AM material is highly **magnetostrictive**, which means that when you put the tag material in a magnetic field, it physically shrinks. The higher the magnetic field strength the smaller the metal becomes. The metal actually shrinks about one-thousandth of an inch over its full 1.50 inch length.

As a result of driving the tag with a magnetic field, the tag is physically getting smaller and larger. So if it is driven at a mechanically resonant frequency, it works like a tuning fork, absorbing energy and beginning to ring.

This tag also requires **bias magnet** material in addition to active element material. The active material will shrink no matter which direction the magnetic field is placed upon it. If the tag is driven with Frequency, F, it gets smaller as the magnetic field increases and larger as it's driven towards zero. This means that while it is being driven at F, the tag is trying to work at 2F, because at both positive and negative halves of the drive signal, the tag is getting smaller. To get the tag to work at F, a bias field is required. The bias is provided by a semi-hard magnetic element in the label. When magnetized, the bias prevents the active element from ever being in a zero field condition. So for an entire half of the drive signal, the tag shrinks. Then it expands for the other half. This results in an F response.

When you walk through the gate with a tag, the transmitter in the gate energizes the material and causes it to resonate at F. The transmitter then stops. The tag will continue to "ring" at F for a short period of time, and the receiver listens for that frequency. If it hears it, it knows there is a tag and sounds the alarm.

When the AM tag is demagnetized, it is deactivated. When it's magnetized, it is activated. (This is the opposite of how the deactivation of EM tags works.)

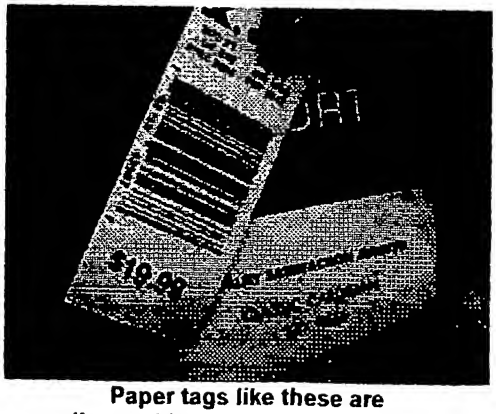
(Home Depot began using acousto-magnetic tags from Sensormatic Electronics Corp. because the tags work well when they're close to metal and the stores use metal shopping carts -- not all systems work well with metal objects.) For more detail on this system, check the patent!

Other EAS technologies include the **microwave system**, one of the oldest anti-shoplifting systems and judged by experts to be only about 80 percent accurate, is still around in some stores. Security experts also caution retailers that this system is not compatible with increasingly popular source tagging options. (We'll discuss source tagging more later!)

What Other Devices and Components Are Used with the EAS Systems?

In addition to the all-important gates or pedestals you walk through, the most important components of EAS systems include the following:

- **Disposable tags** -- Disposable paper tags and labels are available in many different types -- pressure-sensitive labels with simulated bar codes, tags or labels that can be imprinted with price, inventory, promotional or bar-code information, and tags specially designed for products such as earrings, compact discs and cosmetics, which are all items easily pocketed by shoplifters. These thin, adhesive-backed labels can be as small as a paper clip and can be easily disguised to look like standard retail tags. Most importantly, the radio frequency tags, unlike tags connected to some electromagnetic sensors, can't be disrupted by common magnets.



Paper tags like these are disposable and widely used with

- **Reusable tags** --

You'll find these reusable tags on most apparel.

Probably the most familiar reusable tag is the hard, plastic tag (known as an alligator) attached to most apparel and armed with an almost impossible to defeat locking mechanism -- it can also be a pain if it's attached to the wrong part of a garment you want to try on! This off-white, pin-connected tag requires a special detacher unit to remove it. (If you've ever had a clerk accidentally leave one of these on your purchase -- sometimes a tag buried in a bag-full of stuff can go through the sensor without detection, store clerks say -- you know that you cannot get that thing off at home! Some department stores offer a terrific, public relations service: if their clerk fails to remove this tag from your purchase, the store will send someone to your home with a removal device. This means you can wear that new dress to the event you bought it for!) Other reusable tags you might have seen include plastic devices without pins (they use a foam rubber pad! and abrasive strip to grip garment firmly without causing damage), lightweight colored tags encased in clear plastic, flexible tags printed with a simulated bar code, and fluid tags.

- **Benefit denial tags** -- This is a fluid tag. If you steal an item with this kind of tag, you're going to get an unpleasant surprise when you try to remove it in the dressing room or later at home. The ingenious tags have been designed to break and release fluid -- usually colored indelible inks -- onto the garment (working even against gravity) and on you if you try to forcibly remove it. The idea is that a shoplifter is being denied any benefit from his/her crime and will not be able to use or sell the item because it has now been ruined.

- **Deactivators and detachers** -- Desirable qualities in deactivators include a large deactivation zone and 100 percent deactivation with no false alarms. The type of electronic deactivator depends upon the kind of EAS system and tags used by the store. We're all familiar with hand-held **scanners** and flat scanner pads used to swipe and deactivate merchandise tags. Traditionally, scanners must touch a label directly to use specific frequency to deactivate it. But with the growing use of source tagging (hiding identification tags somewhere on an item or in its packaging) **proximity deactivators**, or verifiers that don't require contact with a label, are becoming more important. There are also mass or bulk deactivators, which bring EAS labels from an inactive state to an active state while the products are still packaged in master cartons or cases. A plus of state-of-the-art deactivation devices is that they can be integrated into all of the commercially available bar code scanners. (See How UPC Bar Codes Work) so that clerks are scanning the product code at the same time they're deactivating the security circuit. (See this patent for more information on how a deactivator works.) To remove most hard tags, a **detacher/releaser** is necessary. Today's detachers, which basically unlock the tags, are designed so that they cannot be copied or purchased by shoplifters. Some detachers are hand-held; others are fixed -- most are simple devices with no moving parts, something that makes them very durable.

Store clerks use electronic scanners to deactivate tags on your purchase.

- **Radio frequency identification (RFID)** -- RFID is used in a variety of ways today, including automating toll collection and decreasing time at the gas pump. RF technology xperts say RFID is the way of the future in the retail security arena as soon as the application software is in place. Checkpoint Systems has collaborated with Mitsubishi Materials Corp. to develop **RF int lligent tagging**, which combines an integrated circuit with an RF antenna to deliver a tag capable of

simultaneously storing and processing information about a product while protecting the product from theft. (It can even identify a shoplifter who comes back in wearing a stolen item, since only the security portion of the tag is turned off when an item is purchased. The RFID tag is always on!) Researchers say this technology could someday mean that we don't have to unload our grocery carts for checkout -- the system could gather the information it needs from each item while it remains in the! shopping cart!

- **Accessories and other products** -- In addition to selling hundreds of different types of labels, label applicators, security pins, locking devices for ink tags and security lanyards for use with EAS systems, some companies even offer "dummy" or inactive EAS tags and systems. Retail Security Products claims these tags and labels can be used as stand-alone deterrents to theft, with inactive EAS pedestals or in conjunction with a live EAS system on lower priced items. (They sold over 20 million of the dummy tags -- at 1/3 cents each -- to retailers across the United States last year, they say.) Other manufacturers and experts warn that dummy labels, if used, should be easily distinguishable only to shop personnel.

What Is Source Tagging All About?

As its name implies, source tagging is the embedding of disposable RF security labels at either the point of manufacture or packaging. Source tagging has been highly successful in the packaged products industry, and retailers, such as discount giant Target, are starting to use it for merchandise such as earrings, apparel, shoes, batteries, videocassettes, audiotapes, computer software, sporting goods and electronics. (Retailers' interest in source tagging has increased as shoplifters have gotten around anti-shoplifting tags applied to the outside of packages by removing the product and leaving the empty box on the shelf!)

The newest source tags are paper-thin and easily integrated into automated production processes. These tags are applied in primary packaging (or within or on the product itself -- for example, incorporated into woven garment tags) and under labels on bottles. Checkpoint experts say their two-dimensional source tags can be invisibly embedded between layers of thin paper stock or cardboard on standard blister packages. These invisible tags, which are deactivated by the clerk with a verifier that needs no physical contact with the tag to work, are especially effective at addressing employee theft and represent a hot topic in retail security today.

Sensormatic Products says its tiny Ultra-Strip can be detected through foil, liquids or layers of packaging. (Some industry consultants question the future of source tagging in retail apparel in light of the large number of existing microwave EAS systems -- systems that some consider obsolete and that cannot be adapted to incorporate low-cost source tagging in the future. There are also questions about how best to incorporate source tagging without losing the tag's inherent value as a theft deterrent.)

How Much Does An EAS System Cost? And I've Heard They Can Be Dangerous for People Wearing Internal Medical Devices -- Is That True?

Experts say there are large differences in cost depending on the system, the size of the store and the amount of merchandise to be protected. By using state-of-the-art equipment such as digital signal processing and customized locks that can't be released by common detachers, theft can be reduced by about 60 percent. Considering that store personnel will have more time for assisting shoppers (instead of watching for potential thieves), a reliable EAS system can pay for itself in 1 1/2 to 2 years.

You may have heard news accounts a couple of years ago of research that claimed entry/exit sensors could be harmful to people wearing internal medical devices such as pacemakers and defibrillators. The U.S. Food and Drug Administration acknowledges that internal medical devices might be slightly affected by some EAS systems. However, officials there don't consider this a public health problem. Many Americans were alarmed when the Heart Institute of St. Petersburg, Fla., released results of a two-year study of EAS systems and their possible effects on people wearing pacemakers and

defibrillators. Researchers said they found that the electromagnetic fields of anti-shoplifting systems can interfere with cardiac devices if users linger in the magnetic zone between the pedestals or gates. Soon after, the FDA announced that, of the 1 million Americans with internal medical devices such as pacemakers, there had been only 44 reported reactions over the past 10 years related to anti-theft system magnetic fields. Heart Institute researchers encourage people with internal medical devices to avoid any potential problems by moving quickly through these systems as well as metal detectors.

Now that you know more about the kinds of anti-shoplifting devices being used in stores, take a look at this article on reducing shrinkage (an industry term for lost merchandise) by [illegible] for some additional ideas about security in your imaginary -- or real -- department store.

And if you're someone who needs help conquering a pattern of shoplifting, please contact [illegible] Anonymous. **They can help!**

Lots More Information!

- Checkpoint Systems, Inc.
- Sensormatic Electronics Corp.
- Association of Automated Identification Manufacturers
- Digitag Inc.
- Unisen Inc.
- Electronic Article Surveillance
- Today's Science on File: To Catch a Thief: Anti-shoplifting Tags
- Glossary of Terms
- Radio Frequency Tags: An Alternative to Bar Coding
- New Technology Seeks to Curb Shoplifting